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ABSTRACT

The relationship between Piagetian and school achievement tests was examined through a meta-analysis of correlational data between tests in these domains. Highlighted is the extent to which performance on Piagetian tasks was related to achievement in these areas. The average age for the subjects used in the analysis was 88 months, the average IQ was 107. Mathematics and reading tests were administered. Averaged correlations indicated that Piagetian tests account for approximately 29% of variance in mathematics achievement and 16% of variance in reading achievement. Piagetian tests were more highly correlated with achievement than with intelligence tests. One implication might be the use of Piagetian tests as a diagnostic aid for children experiencing difficulties in mathematics or reading. (Author/GK)

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Meta-Analysis of the Relationship between Piagetian and School Achievement Tests

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Meta-Analysis of the Relationship between Piagetian and School Achievement Tests

Valerie Barnes Jordan and Linda Brownlee

Introduction

This review examined the relationship between Piagetian and school achievement tests through a meta-analysis of correlational data between tests in these two domains. Since school entrance and instruction in mathematics and reading usually coincides with the transition from preoperational to concrete operational thought, it was of interest to document the extent to which performance on Piagetian tasks was related to achievement in these areas. Numerous educational applications of Piaget's stages can be applied to mathematics and reading skills. In mathematics, the transition from preoperational to concrete operational thought reflects changes in children's understanding of cardinal and ordinal properties of numbers; numerical correspondences between groups of N objects; comparative numerical values; and relevent and irrelevent transformations in mathematics operations. In reading, the transition from preoperational to concrete operational thought reflects changes in the understanding of the invariance of letter symbols and word meanings; seriation of word order; and the hierarchical classification of words.

Two types of research strategies have addressed the relationship between Piagetian and achievement tests. One strategy has compared groups of children who differ in conservation or cognitive levels on mathematics and reading tests. A search of the literature has revealed 11 comparative studies, 8 of which report significantly higher achievement scores among conserving children. A second strategy has examined the relationship between Piagetian and achievement tests through correlational methods, and this paper summarizes an analysis of these correlational data.

Method and Data Source

The basic unit of analysis was groups of subjects drawn from studies which met the following criteria. First, only studies in which Piagetian tests were given to intellectually normal children from the preoperational through formal operational stages were included. Second, the range of IQ was not restricted to a particular level or group. Third, the age range of the children was continuous. For example, if a study tested first and third graders and used correlations for the entire group, then these data were not included. However, if the study reported correlations for each group separately, then these data were included and each group treated as an independent sample. Fourth, the correlations used in the studies were product-moment correlations. On the basis of these criteria, 51 studies were located, and from these studies, data for 65 independent groups containing over 6000 children were analyzed. The average mean chronological age for these children was 88 months, with a range from 65 to 181 months. The average mean IQ, based on 20 studies which reported IQ information, was 107, with a range from 98 to 121.

The mathematics tests were summarized into two categories. One included total grade equivalent scores from standardized mathematics tests such as the CTBS, MAT, SAT and WRAT, and the second included raw scores from nonstandardized mathematics tests designed by the authors of 7 studies. The reading tests were summarized into three categories of standardized tests such as the CAT, CTBS, MAT, SAT and others: reading readiness batteries, general reading batteries and general language batteries. The Piagetian tests were summarized into four categories: conservation, logical operations, general concrete operational batteries and formal operations. The following averaging procedure for the correlations was adopted. Within a particular study, if more than one correlation was available within any Piagetian or achievement category, then these correlations were averaged within that study. Once averaged correlations within studies were obtained, then correlations across studies within the same test category were averaged using Fisher's r-to-Z transformation which weighted each correlation by the sample size on which each correlation was based. For example, a study might report correlations between three conservation tasks and a standardized mathematics test, so the three conservation correlations were averaged for a total conservation and mathematics correlation, and then that averaged correlation was combined with the other Piagetian categories for the total Piagetian-mathematics averaged correlation.

Results and Conclusion

The total averaged correlation across all Piagetian and mathematics categories, based on 36 groups, was .54 (.57 for standardized and .49 for nonstandardized tests). The total averaged correlations between each Piagetian category and total mathematics were .73 for general concrete operational batteries, .59 for logical operations, .43 for conservation, and .25 for formal operations. Seriation yielded the highest correlation with total mathematics among the logical operations tests (averaged $r = .63$), while area, number and quantity yielded the highest correlations with total mathematics among the conservation tests (averaged r's = .47, .43 and .40 respectively). When comparisons could be made, the averaged correlations between each Piagetian category and standardized and nonstandardized tests were relatively similar in size. In addition, an inverse relationship was found between mean age and the size of the Piagetian-mathematics correlations (Spearman rho = -.49, $p < .01$), indicating that Piagetian tests were better predictors of mathematics performance among younger children.

The total averaged correlation across all Piagetian and reading categories, based on 42 groups, was .40. The total averaged correlations across all Piagetian categories with each reading category were .54 for reading readiness, .35 for language, and .33 for reading. The total averaged correlations between each Piagetian category across all reading tests were .55 for general concrete operational batteries, .45 for logical operations, .33 for conservation and .32 for formal operations. Seriation yielded the highest correlation with total reading among the logical operations tests(averaged $r = .62$), while volume, weight and length yielded the highest correlations with total reading among the conservation tests (averaged r's = .39, .36 and .35 respectively). In 80% of the possible comparisons, the averaged correlations with each Piagetian category were higher with mathematics than with reading tests.

These averaged correlations indicate that Piagetian tests account for approximately 29% of the variance in mathematics achievement and 16% of the variance in reading achievement. The averaged correlation between IQ and the same Piagetian categories, based on a separate review of 37 groups, was .33, indicating that Piagetian tests are more highly correlated with achievement than with intelligence tests. It was not possible to estimate the degree to which the Piagetian-achievement test relationship could be attributed to their mutual relationship with IQ, since few studies contained partial correlations among Piagetian, achievement and intelligence tests. It would be desirable for studies to report all three sets of correlations so that the contributions of each test could be independently evaluated.

Educational Implications

This analysis suggests that a moderate relationship exists between Piagetian and achievement tests. One implication of these findings might be the use of Piagetian tests, particularly seriation, as a diagnostic aid for children who are experiencing difficulties in mathematics or reading. It is possible that remedial experiences in selected Piagetian tasks might improve the achievement test performance of low achieving children.

Table 1

Summary Statistics of Group Characteristics by Type of Achievement Test

Group Characteristics	Standardized Mathematics	Nonstandardized Mathematics	Total Mathematics	Total Reading
Average M Age	94	78	90	90
R	65-153	65-102	65-153	66-181
M Size of Age Range	16	12	15	19
R	11-50	6-25	6-50	12-53
M IQ[a]	109	105	109	109
R	104-121	104-106	104-121	98-121
M Sample Size	69	103	79	82
R	19-356	24-338	19-356	12-356
N Groups	26	10	36	42
N Studies	17	7	24	37

Note. Chronological ages are reported in months.

[a]Number of groups reporting IQ data in each test category are 11, 2, 13 and 16 respectively.

Table 2

Rank Order Correlations between Group Characteristics and Piagetian-Achievement Test Correlations

	Correlation between Piagetian Tests and:			
Group Characteristics	Standardized Mathematics	Nonstandardized Mathematics	Total Mathematics	Total Reading
M Age	-.52**	-.43	-.49**	-.20
Size of Age Range	-.16	.00	-.18	.10
M IQ[a]	-.32	.00	-.50	-.31
M Sample Size	.01	-.41	-.09	-.05
N Groups	26	10	36	42
N Studies	17	7	24	37

[a]Number of groups reporting IQ data in each test category are 1, 2, 13 and 16 respectively.

Figure 1

Averaged Correlations between Piagetian and School Achievement Tests by Type of School Achievement

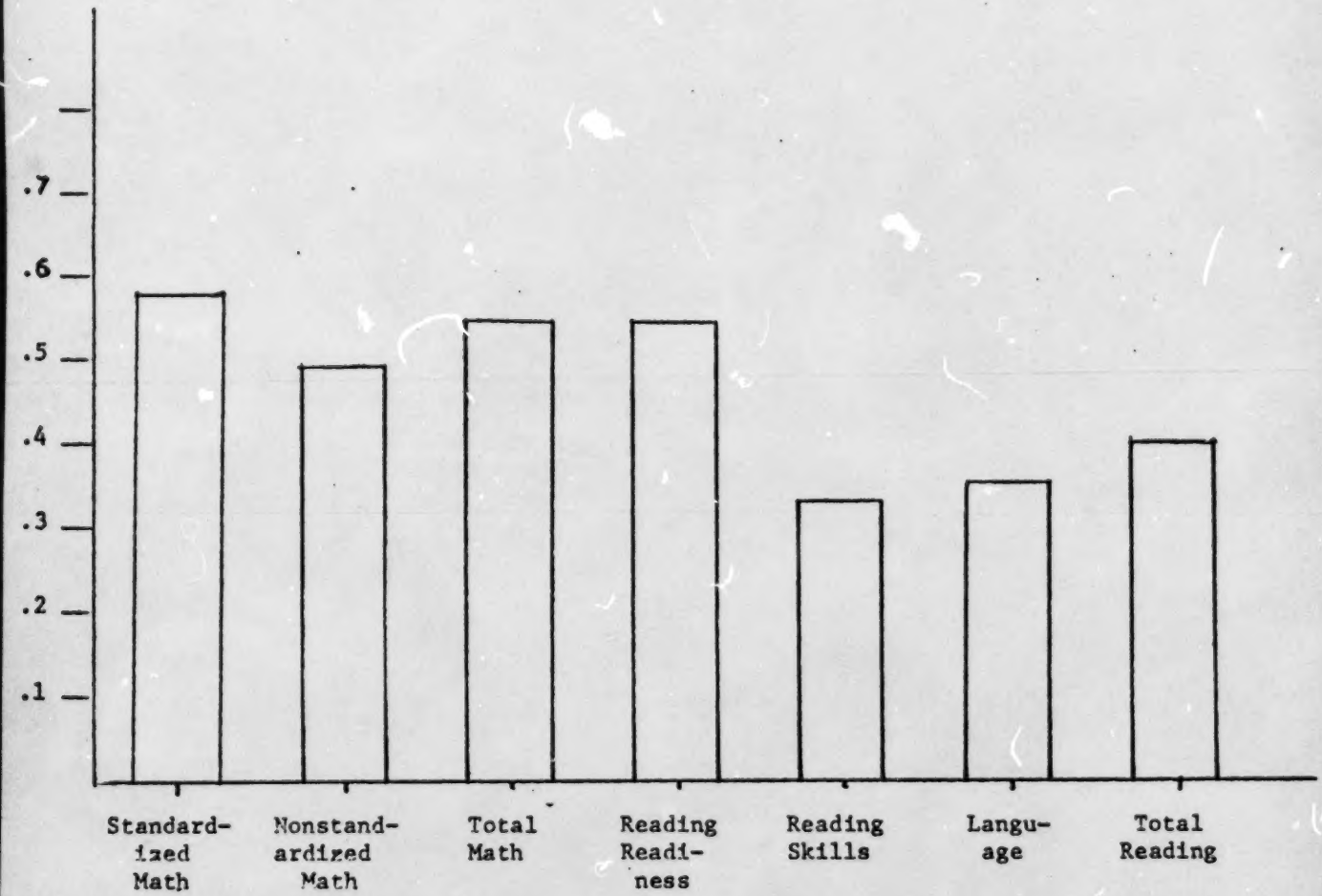

Figure 2

Averaged Correlations between Piagetian and School Achievement Tests

by Type of Piagetian Test